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Reconfigurable Microstrip Antennas: A Review

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ABSTRACT
Reconfigurable micro-strip antenna provides numerous application and offer more versatility as compared to conventional antennas which offer one function in a single antenna. They can provide diversity function in operating frequency, radiation pattern and polarization to mobile communications Antennae with polarization diversity are gaining popularity due to the tremendous growth of wireless communications and radar systems. Main objective of this article is to study and analyze findings of various reconfigurable micro-strip antennas.

Keywords: Reconfigurable Antennas, Unmanned Airborne Vehicle**,** Universal Mobile Telecommunications System, Dedicated short-range communications, Worldwide Interoperability for Microwave Access

1. INTRODUCTION

1.1 Reconfigurable Antenna

Traditionally wireless systems are designed for single predefined mission. Therefore, the antennas of these systems also possess some fixed parameters such as frequency band, radiation pattern, polarization, and gain. Recently reconfigurable antennas (RAs) have gain tremendous research interest for many different applications, for example, cellular radio system, radar system, satellite communication, airplane, and unmanned airborne vehicle (UAV) radar, smart weapon protection [1]. If the desired operating characteristics of the antenna change, then the antenna must be reconfigured or rebuilt to meet the new specifications. Reconfigurable antennas change their performance characteristics by altering the current flow on an antenna, using mechanically movable parts, phase shifters, attenuators, diodes, tunable materials, or active materials. A reconfigurable antenna can be a single antenna or an array [2]. In mobile and satellite communications, reconfigurable antennas are useful to support a large number of standards (e.g., UMTS, Bluetooth, Wi-Fi, WiMAX, DSRC) to mitigate strong interference signal and to cope with the changing environmental condition. On the other hand, in radar applications, reconfigurabilty at antenna level is often needed for multifunctional operation. This feature is achieved by utilizing antenna array systems that can be quickly adapted according to the mission [1]. The first reconfigurable antennas had mechanically movable parts (as in Figure 1).

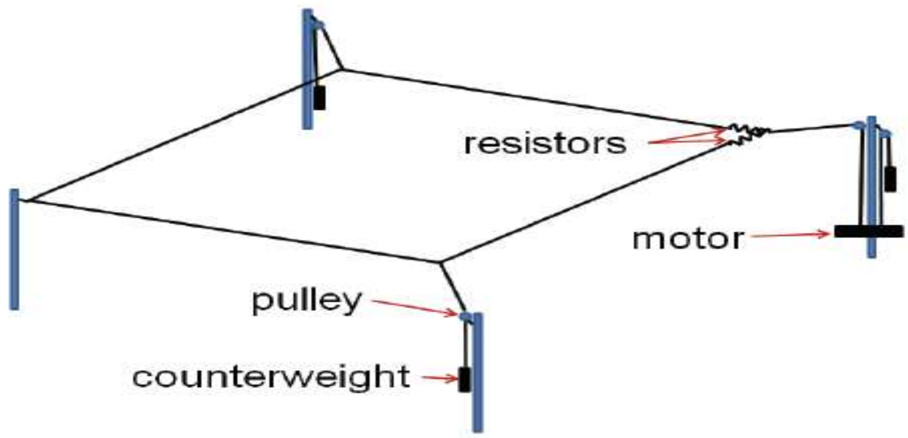

Figure 1: A steerable horizontal rhombic antenna [1]

1.2 Design of Reconfigurable micro-strip patch antenna

Micro-strip patch antenna is mostly used in modern communication devices over conventional antennas mainly because of their size [3] [7]. Micro-strip patch antennas are of much interest in antenna applications. They are easy and cheap to manufacture. Micro-strip patch antennas are capable of being designed as a single element or as part of an array. Whereas, these advantages do not hide the low efficiency and limited bandwidth of micro strip patch antenna. In recent years research has also been done to use the single antenna in many applications that is antenna must exhibits the property of switching from one application to another upon configuration request and such antennas are called reconfigurable antennas. Recent trends have seen the development of wideband antennas, multi-band antennas or reconfigurable antennas receiving much attention to fulfill different applications in just one single terminal [4] [8]. Reconfigurable micro-strip antenna provides numerous application and offer more versatility as compared to conventional antennas which offer one function in a single antenna. They can provide diversity function in operating frequency, radiation pattern and polarization to mobile communications. The main disadvantages of micro-strip patch antenna radiation performance including narrow bandwidth. Various techniques have been included to overcome these disadvantages [9].

1.3 Feeding Techniques

Micro-strip patch antenna can be fed by a variety of methods. These methods can be classified into two categories-contacting and non-contacting. In the contacting method, the RF power is fed directly to the radiating patch using a connecting element such as a micro-strip line. In the non-contacting method, electromagnetic field coupling is done to transfer power between the micro-strip line and the radiating patch. There are four most popular technique used here they are i) Micro-strip line ii) Coaxial line iii) aperture coupling iv) proximity coupling. Micro-strip patch antennas have radiating element on one side of a dielectric substrate and thus may be fed by any of this four technique. Matching is usually required between the fed line and the antenna input impedances [5] [6].

1.3.1 Micro-strip Line Feed

Micro-strip line fed is conducting strip, usually of much smaller width compared to patch. It is easy to fabricate, simple to match by controlling the inset position. If we increases the thickness of the substrate surface waves and spurious fed radiation increases. And its bandwidth is very limited. The purpose of the inset cut in the patch is to match the impedance of the fed line to the patch, without the need for any additional matching element. This is achieved by properly controlling the inset position [10] [11].

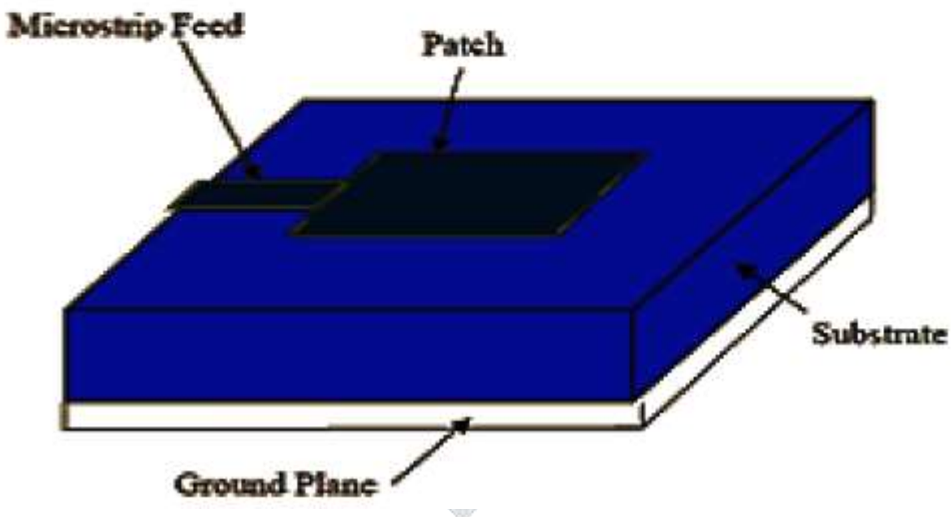

Figure 2: Micro-strip line feed [7]

1.3.2 Coaxial Feed

It is a common technique used for feeding micro-strip patch antenna. Inner conductor of the coaxial connector extends through the dielectric and is soldered to the radiating patch, while the outer conductor is connected to the ground plane. The advantage of this type of feeding scheme is that the fed can be placed at any desired location inside the patch in order to match its input impedance. Its major disadvantage is that it provide narrow bandwidth and is difficult to model since a hole has to be drilled in the substrate and the connector protrudes outside the ground plane, thus not making it completely planar for thick substrates [12].

1.3.3 Aperture Couple Feed

Coupling between the patch and the feed line is made through a slot or an aperture in the ground plane. In this technique transmission line is shielded from the antenna by a conducting plane with a hole to transmit energy to antenna as shown in Figure 3 .

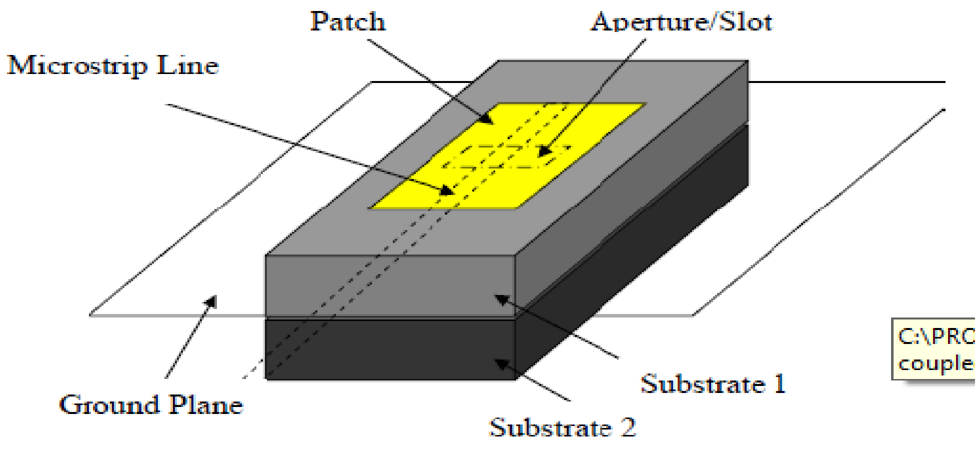

Figure 3: Aperture Couple Feed [8]

The upper substrate can be made with a lower permittivity to produce loosely bound fringing fields, yielding better radiation. The lower substrate can be independently made with a high value of permittivity for tightly coupled fields that don't produce spurious radiation. The disadvantage of this method is increased difficulty in fabrication.

1.3.4 Proximity Couple Feed

This type of feed technique is also called as the electromagnetic coupling scheme. It has the largest bandwidth, has low spurious radiation. Fabrication of proximity coupling is very difficult. Length of feeding substrate and width to length ratio of patch is used to control the match. Its coupling mechanism is capacitive in nature [9] [13].

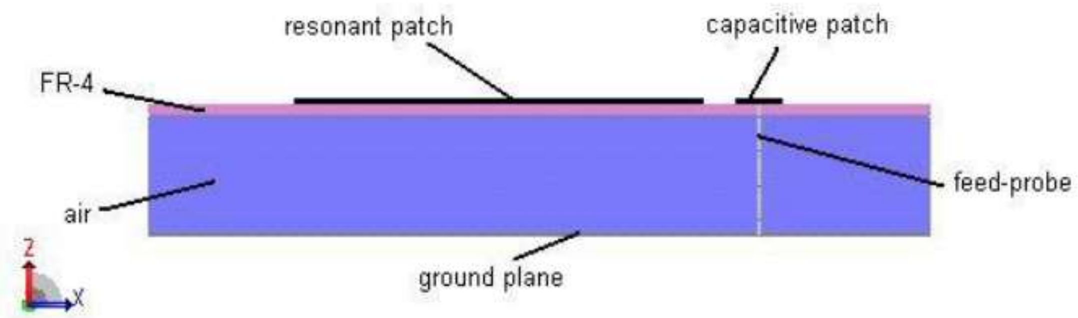

Figure 4: Proximity Couple Feed [9]

2. LITERATURE REVIEW

Table 1: Findings of Various Antenna designing Techniques

Author (s)	Year	Approach/Technology Used	Findings
Bedri A. Cetiner	2005	Rectangular-shaped bent metallic strips interconnected to each other with RF-MEMS actuators.	The operating frequency of the presented antenna design can easily be adjusted to be compatible with popular IEEE networking standards such as 802.11a.
Hattan F. Abutarboush	2012	The antenna consists of a main patch, four sub-patches, and a ground plane to generate five frequency bands, at 0.92, 1.73, 1.98, 2.4, and 2.9 GHz, for different wireless systems.	By putting varactors (diode) at each of the sub-patch inputs, four of the frequency bands can be controlled independently over wide ranges and the antenna has a reconfigurable design.
Izni Husna Idris	2012	A frequency reconfigurable slot dipole antenna. The antenna incorporates three	The antenna was designed to operate at 2.4 GHz, 3.5 GHz and 5.2 GHz. The

		pairs of pin diodes which are located within the dipole arms.	average measured gains are 1.54, 2.92 and 1.89 dBs for low, mid and high band respectively.
Ch. Sulakshana	2012	Compact single feed rectangular patch antenna with reconfigurable circular polarization.	The polarization of the proposed antenna can be reconfigured between left hand circular polarization (LHCP) and right hand circular polarization (RHCP) by the current path, which is changed by operating the switches in ON and OFF modes.
Aaron J. King	2013	Frequency-reconfigurable slot antennas enabled by pressure-driven capacitive micro fluidic switches.	Frequency reconfigurabilty is achieved by altering the displacement of conductive fluid within the channel, which reactively loads the slot.
Harender Pal Singh	2017	Analyzed the performance of Microstrip patch antenna with and without using the Meta material structure	There is an improvement in return loss of around 6 dB This rectangular patch antenna is simulated and tested using HFSS Simulator.
Veerendra Singh Jadaun	2018	Microstrip line fed antenna.	This antenna has shown -43.03 dB return loss at 1.8 GHz resonant frequency. At this frequency antenna radiate maximum transmitted power and reflects minimum power.
Ranjan Mishra	2019	Rectangular and square shaped Microstrip antenna.	Proposed Microstrip antenna is showing a wide bandwidth of 500 MHz with a high return loss of -24 dB. This high bandwidth provides its usefulness in many wideband utilities in X-band.
Sathishkumar N	2020	Microstrip antennas.	By integrating a rectangular patch in the Substrate, a Microstrip patch antenna is developed and is compact and cost-effective.

CONCLUSION

Reconfiguring an antenna is achieved by deliberately changing its frequency, radiation characteristics or polarization. Change in electromagnetic fields of the antenna's effective aperture can be achieved by many techniques by redistributing the antenna currents. Reconfigurable antennas can solve complex system requirements by changing their geometry and electrical behavior, thereby adjusting to changes in environmental conditions i.e., changes in operating frequency, polarization, and radiation pattern. Reconfigurabilty at antenna level is often required for multifunctional operation. This feature is accomplished by employing antenna array systems that can be quickly adapted according to the mission. Therefore, a control over operating frequency, beam pointing direction, polarization, antenna gain, and so forth is required. The implementation of several functionalities on the same antenna requires topological reconfigurabilty to achieve radiation pattern and frequency agility. In particular, parameters such as the shape and size of the array and the grid spacing should be changed to adapt to the requirements set by the considered functionality.

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